REMARKS

This Amendment responds to the Office Action dated October 1, 2004 in which the Examiner rejected claims 1-9 and 19-27 under 35 U.S.C. § 112, first paragraph, and rejected claims 1-27 under 35 U.S.C. § 103.

As indicated above, claims 1, 8, 9, 19, 26 and 27 have been amended to comply with the written description requirement. Applicants respectfully requests the Examiner approves the correction and withdraws the rejection to claims 1-9 and 19-27 under 35 U.S.C. §112, first paragraph.

As indicated above, claims 1, 8-10, 17-19, 26-27 have been amended to make explicit what is implicit in the claims. Applicant respectfully submits that the amendment is unrelated to a statutory requirement for patentability and does not narrow the literal scope of the claims.

Claims 1, 8 and 9 claim a method of patterning a thin film, a method of manufacturing a thin film device and a method of manufacturing a thin-film magnetic head. The various methods comprise the steps of forming at least one strippable film on a surface of a thin film to be patterned, directly patterning the at least one strippable film together with the thin film to be patterned by using focused ion beam etching and then removing the etched at least one strippable film.

Through the method of the claimed invention forming a strippable film on a surface of a thin film to be patterned, and directly patterning the strippable thin film together with the thin film using focused ion beam etching as claimed in claims 1, 8 and 9, the claimed invention provides a thin film to be patterned which is prevented from being damaged due to electric charge. In addition, pattern resolution or pattern

precision can be improved. The prior art does not show, teach or suggest the invention as claimed in claims 1, 8 and 9.

Claims 10 claims a method of patterning a thin film, claim 17 claims a method of manufacturing a thin film device and claim 18 claims a method of manufacturing a thin film magnetic head. The methods comprise the steps of forming at least one strippable film, directly patterning the at least one strippable film using focused ion beam etching, depositing a thin film to be patterned by using the etched at least one strippable film and removing the etched at least one strippable film.

Through the method of the claimed invention directly patterning at least one strippable film using focused ion beam etching and then depositing a thin film to be patterned, as claimed in claims 10, 17 and 18, the claimed invention provides a thin film which is not directly etched by focused ion beam etching so that the thin film can be prevented from damage due to electric charge. The prior art does not show, teach or suggest the invention as claimed in claims 10, 17 and 18.

Claims 19 claims a method of patterning a thin film, claim 26 claims a method of manufacturing a thin film device, and claim 27 claims a method of manufacturing a thin-film magnetic head. The methods comprise the steps of forming at least one strippable film on a surface of a thin film to be patterned, directly patterning the at least one strippable film together with the first thin film to be patterned by using focused ion beam etching, depositing a second thin film to be patterned using the at least one strippable film and the patterned first thin film to be patterned as a mask and removing the etched at least one strippable film.

Through the method of the claimed invention forming at least one strippable film on a surface of a thin film to be patterned, directly patterning the strippable film

together with the first thin film using focused ion beam etching and depositing a second thin film using the strippable film and first thin film as a mask, as claimed in claims 19, 26 and 27, the claimed invention provides a thin film which is not directly etched by focused ion beam etching so that the thin film is prevented from being damaged by electric charge. The prior art does not show, teach or suggest the invention as claimed in claims 19, 26 and 27.

Claims 1, 2, 4, 6, 8-11, 17-20, 26 and 27 were rejected under 35 U.S.C. § 103 as being unpatentable over *Mamin et al* (U.S. Patent No. 6,055,220).

Mamin et al. appears to disclose optical disk data storage systems of the type that use a solid immersion lens to reduce the size of the light beam at the data layer on the disk. (col. 1, lines 6-8) The solid immersion lens (SIL) reduces the spot size by using a high NA lens made of high index of refraction (n) material. (col. 1, lines 64-66) An optical disk drive with an air-bearing slider supporting a SIL and with a patterned thin film is formed on the slider at the focus of the SIL to act as a secondary radiation source. (col. 3, lines 2-5) The lithographic techniques for making apertures can also be used to make the scatterer 210 in the embodiment of FIG. 5B, as shown by FIGS. 8A-8D. For example, a thin sacrificial resist, such as polymethylmethacrylate (PMMA), is placed on the planar surface of the SIL, as shown in FIG. 8A. Optical, electron beam, or focused ion beam (FIB) lithography is then used to define a small opening in the resist, as shown in FIG. 8B. A thin metal layer, such as silver (Ag), is then evaporated onto the resist and onto the planar surface of the SIL in the region of the opening, as shown in FIG. 8C. Lift-off of the PMMA leaves just the small silver particle that serves as the scatterer, as shown in FIG. 8D. To protect the air-bearing surface of the SIL, the film that forms the

aperture can be a hard protective coating, such as SiN or hard carbon. (col. 6, lines 49-64) In FIG. 9, for example, the scatterer 210 is embedded in a layer of silicon nitride (SiN). The SiN protects the air-bearing surface of the SIL, as well as the scatterer 210. A self-explanatory sequence of steps to form the structure of FIG. 9 is shown in FIGS. 10A-10F. (col. 7, lines 5-9)

Thus, *Mamin et al* merely discloses in Figure 10B using FIB to form an opening in a SiN layer which is subsequently covered by a photoresist (Figure 10C). Thus nothing in *Mamin et al* shows, teaches or suggests forming a strippable film on a surface of a thin film to be patterned as claimed in claims 1, 8, 9, 19, 26 and 27. Rather, the photoresist is formed on a layer SiN which is already patterned (i.e., *Mamin et al* does not show, teach or suggest that layer SiN is to be further patterned).

Also, *Mamin et al* merely discloses in Figure 10D removing a photoresist from an opening formed in layer SiN. Nothing in *Mamin et al* shows, teaches or suggests directly patterning both a strippable film and a thin film to be patterned using focused ion beam etching as claimed in claims 1, 8, 9, 19, 26 and 27. Rather, *Mamin et al* merely discloses removing a photoresist from an opening formed in a SiN layer. Also, *Mamin et al* does not disclose how the photoresist is removed.

Applicant respectfully points out to the Examiner that since a strippable film is formed on a thin film to be patterned and then both the strippable film together with the thin film are directly patterned using focused ion beam etching as claimed in claims 1, 8, 9, 19, 26 and 27, even if the focused ion beam is not completely focused but spread, only upper edges of the pattern of the strippable film, which is removed after the patterning, is etched and thus upper edges of the thin film to be patterned

are not needless etched. As a result, resolution of the patterning is greatly increased in order to improve patterning precision. Nothing in *Mamin et al* shows, teaches or suggests directly patterning a strippable film together with a thin film to be patterned using focused ion beam etching and then removing the strippable film as claimed in claims 1, 8, 9, 19, 26 and 27.

Additionally, *Mamin et al* merely discloses in Figure 10D removing a photoresist from an opening formed in layer SiN and then forming a metal layer on the photoresist and in the opening in layer SiN (Figure 10E). Nothing in *Mamin et al* shows, teaches or suggests a) directly patterning at least one strippable film using focused ion beam etching (Figure 10D of *Mamin et al* merely discloses removing the photoresist from the opening in layer SiN and how it is removed is not disclosed), b) depositing a thin film to be patterned by using the etched at least one strippable film (*Mamin et al* does not disclose in Figure 10E that the photoresist is used (as a mask) when the metal is deposited in Figure 10E nor is the metal in Figure 10E described as a thin film to be patterned) and c) removing the etched at least one strippable film as claimed in claims 10, 17 and 18. Rather, *Mamin et al* merely discloses forming a metal layer on top of the photoresist and in the opening formed in SiN layer. *Mamin et al* does not indicate how the photoresist is removed in Figure 10D.

Applicant respectfully points out to the Examiner that since the mask pattern used in a lift-off process is etched by using focused ion beam etching, as claimed in claims 10, 17 and 18, even if the focused ion beam is not completely focused but spread, only upper edges of the pattern of the strippable film, which is removed after the patterning, is etched and lower edges of the strippable film which are important as the mask pattern are not needlessly etched. As a result, resolution of pattern is

greatly increased to improve patterning precision. Nothing in *Mamin et al* shows, teaches or suggests directly patterning a strippable film using focused ion beam etching, depositing a thin film to be patterned by using the etched strippable film and removing the strippable film as claimed in claims 10, 17 and 18.

Since nothing in *Mamin et al* shows, teaches or suggests the features as claimed in claims 1, 8, 9, 10, 17, 18, 19, 26 and 27, applicant respectfully requests the Examiner withdraws the rejection to claims 1, 8, 9, 10, 17, 18, 19, 26 and 27 under 35 U.S.C. §103.

Claims 2, 4, 6, 11 and 20 depend from claims 1, 10 and 19 and recite additional features. Applicant respectfully submits that claims 2, 4, 6, 11 and 20 would not have been obvious within the meaning of 35 U.S.C. §103 over *Mamin et al* at least for the reasons as set forth above. Therefore, applicant respectfully requests the Examiner withdraws the rejection to claims 2, 4, 6, 11 and 20 under 35 U.S.C. §103.

Claims 1, 8-10, 17-19, 26 and 27 were rejected under 35 U.S.C. §103 as being unpatentable over *Nakamura et al* (U.S. Patent No. 5,506,197) in view of *Mamin et al.*

Nakamura et al. appears to disclose as shown in FIG. 3A, an MgO (100) substrate 5 is prepared. As shown in FIG. 3B, a c-axis oriented $Y_1Ba_2Cu_3O_{7-\delta}$ oxide superconductor thin film 1 having a thickness of about 250 nanometers is deposited on a principal surface of a MgO substrate 5. (col. 10, lines 23-27) Then, as shown in FIG. 3C, an Au layer 14 having a thickness of 30 to 100 nanometers is formed on the $Y_1Ba_2Cu_3O_{7-\delta}$ oxide superconductor thin film 1. As shown in FIG. 3D, a SiO_2 layer 15 having a thickness of 250 nanometers is formed on the Au layer 14 by a

CVD. A center portion of the SiO_2 layer 15 is removed by using a photolithography. Using the processed SiO_2 layer 15 as a mask, center portions of the Au layer 14 and the $Y_1Ba_2Cu_3O_{7-\delta}$ oxide superconductor thin film 1 are selectively etched by a reactive ion etching using a chloric gas, an ion milling using Ar-ions or a focused ion beam etching so that the Au layer 14 is divided into a source electrode 12 and a drain electrode 13, the $Y_1Ba_2Cu_3O_{7-\delta}$ oxide superconductor thin film 1 is divided into a superconducting source region 2 and a superconducting drain region 3, and a portion 16 of the surface of the substrate 5 is exposed between them, as shown in FIG. 3E. As shown in FIG. 3F, an oxide layer 20 composed of c-axis oriented $Pr_1Ba_2Cu_3O_{7-\varepsilon}$ is deposited on the exposed surface 16 of the substrate 5, by an MBE. The oxide layer 20 preferably has a half thickness of the superconducting source region 2 and the superconducting drain region 3. (col. 10, lines 38-54) As shown in FIG. 3F, an oxide layer 20 composed of c-axis oriented $Pr_1Ba_2Cu_3O_{7-\varepsilon}$ is deposited on the exposed surface 16 of the substrate 5, by an MBE. The oxide layer 20 preferably has a half thickness of the superconducting source region 2 and the superconducting drain region 3. (col. 10, lines 59-64) Then, the Pr molecular beam source is exchanged to a Y molecular beam source and the temperature of the substrate is lowered to 700°C. so that a superconducting channel 10 of a c-axis oriented Y_1 $Ba_2Cu_3O_{7-\delta}$ oxide superconductor thin film having a thickness of about 5 nanometer is continuously formed on the oxide layer 20 of $Pr_1Ba_2Cu_3O_{7-\varepsilon}$ thin film, as shown in FIG. 3G. Thereafter, as shown in FIG. 3H, a gate insulating layer 7 of MgO is formed by a sputtering successively on the superconducting source region 2, the superconducting channel 10 and the superconducting drain region 3. Then, as shown in FIG. 3I, a gate electrode 4 of Au is formed on a center portion of the gate

insulating layer 7 by a vacuum evaporation. Finally, as shown in FIG. 3J, the SiO_2 layer 15 is removed by using a 10% HF solution. (col. 11, lines 9-26)

Thus, *Nakamura et al.* merely discloses at column 10, lines 38-54, forming a SiO_2 layer 15 on a Au layer 14. Nothing in *Nakamura et al.* shows, teaches or suggests forming at least one strippable film on a surface of a thin film to be patterned as claimed in claims 1, 8, 9, 19, 26 and 27. Rather, layer 15 is formed on Au layer 14.

Additionally, *Nakamura et al.* merely discloses that the center portion of layer 15 is removed using photolithography and is thereafter used as a mask (column 10, lines 41-44). Thus, nothing in *Nakamura et al.* shows, teaches or suggests directly patterning a strippable film together with a thin film to be patterned using focused ion beam etching as claimed in claims 1, 8, 9, 19, 26 and 27. Rather, *Nakamura et al.* merely discloses using photolithography to remove a portion of layer 15 prior to patterning thin film 1.

Also, *Nakamura et al.* merely discloses that layer 15 is used as a mask so that Au layer 14 and thin film 1 are divided into source electrode 12, source region 2, drain electrode 13 and drain region 3 by etching or milling (column 10, lines 44-54). Thus, nothing in *Nakamura et al.* shows, teaches or suggests directly patterning a strippable film together with a thin film using focused ion beam etching as claimed in claims 1, 8, 9, 19, 26 and 27. Rather, only after layer 15 is formed into a mask using photolithography is the thin film 1 etched together with Au layer 14.

Furthermore, *Nakamura et al.* merely discloses that layer 15 is removed using photolithography and is used as a mask in order to etch Au layer 14 and thin film 1. Nothing in *Nakamura et al.* shows, teaches or suggests directly patterning the at

least one strippable film by using focused ion beam etching and depositing a thin film to be patterned by using the etched at least one strippable film as claimed in claims 10, 17 and 18. Rather, *Nakamura et al.* teaches away from the claimed invention since the layer 15 is removed by photolithography and thus is not directly patterned by focused ion beam etching. Secondly, nothing in *Nakamura et al.* shows, teaches or suggests depositing a thin film to be patterned using the etched at least one strippable film as claimed in claims 10, 17 and 18. Even assuming *arguendo* that the subsequently deposited oxide layer 20 or channel layer 10 are a depositing film, these layers are never to be patterned using the etched at least one strippable film as claimed in claims 10, 17 and 18.

As discussed above, *Mamin et al.* merely discloses forming an opening in layer SiN using FIB and subsequently forming a photoresist thereon. Applicants respectfully submit that nothing in *Mamin et al.* shows, teaches or suggests directly patterning a strippable film together with a thin film to be patterned using focused ion beam etching and removing the strippable film as claimed in claims 1, 8, 9, 19, 26 and 27, nor does *Mamin et al.* show, teach or suggest directly patterning a strippable film using focused ion beam etching and depositing a thin film to be patterned by using the etchable strippable film as claimed in claims 10, 17 and 18. Rather, *Mamin et al.* merely discloses forming an opening in SiN layer, forming a photoresist thereon, removing the photoresist from the opening formed in layer SiN and forming a metal layer thereon.

Applicant respectfully submits that since neither *Nakamura et al.* nor *Mamin et al.* shows, teaches or suggests the features as claimed in claims 1, 8, 9, 10, 17, 18, 19, 26 and 27, nothing in the combination of these references shows, teaches or

suggests the primary features of these claims. Therefore, applicant respectfully requests the Examiner withdraws the rejection to claims 1, 8-10, 17-19, 26 and 27 under 35 U.S.C. §103.

Claims 1-9 were rejected under 35 U.S.C. § 103 as being unpatentable over *Taylor et al.* (U.S. Patent No. 4,377,437).

Taylor et al. appears to disclose a lithography technique for use in the production of solid state devices. (col. 1, lines 8-9) It is desirable to obtain resist materials that can be exposed with relatively low energy ion beams while achieving fine line pattern generation. (col. 1, lines 64-66) A lithographic process is disclosed whereby ions are selectively implanted in a material and subsequently exposed to a reactive atmosphere. The implanted species react with the reactive atmosphere to form a nonvolatile protective compound in the implanted regions of the material, so that such protected regions are etched at a slower rate than unprotected regions when the material is exposed to a plasma. Typically, the reactive atmosphere used to form the protective compound is also the plasma used for etching. A negative tone pattern is thereby produced in the material. (col. 2, lines 5-16) The following detailed description relates to a lithography process whereby ions are selectively implanted into a material and subsequently treated to form a negative tone pattern in the material. (col. 2, lines 23-26) The ionic species, typically implanted to a mean depth less than 50 percent of the thickness of the material being implanted, is subsequently treated with a reactive atmosphere, typically an oxygen or halogen-containing plasma, to form a protective compound in the implanted regions of the material. (col. 2, lines 33-38) The material is then etched in a plasma so that the

unprotected regions are removed at a faster rate than the protected regions, yielding a negative tone pattern. (col. 2, lines 43-46)

Thus, *Taylor et al.* is merely directed to a lithography technique in which resist materials can be exposed to a relatively low energy beam in order to subsequently etch them into a fine line pattern. Nothing in *Taylor et al.* does not shows, teaches or suggests a) a method of patterning a thin film, b) a method of manufacturing a thin film device or c) a method of manufacturing a thin-film magnetic head as claimed in claims 1, 8 and 9. Rather, *Taylor et al.* is directed to a lithography technique in which ions are selectively implanted and subsequently exposed in a reactive atmosphere to produce a negative tone pattern.

Additionally, since *Taylor et al.* is directed to a lithography technique for producing a negative tone pattern, nothing in *Taylor et al.* shows, teaches or suggests forming at least one strippable film on a surface of a thin film to be patterned and directly patterning the strippable film together with the thin film using focused ion beam etching as claimed in claims 1, 8 and 9. Rather, *Taylor et al.* is merely directed to selectively implanting materials and subsequently treating to form a negative tone pattern in the material.

Applicant respectfully submits that *Taylor et al.* merely discloses that focused ions are selectively implanted into a material to form protected regions and unprotected regions and then the material is etched in a plasma to remove the unprotected regions to form a mask layer. Thus, nothing in *Taylor et al.* shows, teaches or suggests both a strippable film and a thin film to be patterned are directly patterned by focused ion beam etching and then the strippable film is removed as claimed in claims 1, 8 and 9. Rather, *Taylor et al.* merely discloses executing ion-

implantation directly on a material without using a mask, whereas focused ion beam is executed directly on a strippable film without using a mask, as claimed in claims 1, 8 and 9.

Additionally, in *Taylor et al.*, a layer under the material is etched by a plasma using an ion-implanted material as a mask whereas as claimed in claims 1, 8 and 9, a thin film to be patterned and simultaneously and directly patterned by focused ion beam etching. Also, nothing in *Taylor et al.* shows, teaches or suggests that the mask layer is strippable and removed as claimed in claims 1, 8 and 9.

Since nothing in *Taylor et al.* shows, teaches or suggests or suggests a method of patterning a thin film, method of manufacturing a thin film device, method of manufacturing a thin-film magnetic head, forming at least one strippable film on a surface of a thin film to be patterned and directly patterning the at least one strippable film together with the thin film using focused ion beam etching as claimed in claims 1, 8 and 9, Applicant respectfully requests the Examiner withdraw the rejection to claims 1, 8 and 9 under 35 U.S.C. § 103.

Claims 2-7 depend from claim 1 and recite additional features. Applicant respectfully submits that claims 2-7 would not have been obvious within the meaning of 35 U.S.C. § 103 over *Taylor et al.* at least for the reasons as set forth above. Therefore, Applicants respectfully requests the Examiner withdraw the rejection to claims 2-7 under 35 U.S.C. § 103.

Claims 11-16 and 20-25 were rejected under 35 U.S.C. § 103 as being unpatentable over *Nakamura et al., Mamin et al.* and further in view of *Taylor et al.*

As discussed above, since nothing in the combination of the primary references shows, teaches or suggests the primary features as claimed in claims 10

and 19, applicant respectfully submits that the combination of the primary reference with the secondary reference would not overcome the deficiencies of the primary reference. Therefore, applicant respectfully requests the Examiner withdraws the rejection to claims 11-16 and 20-25 under 35 U.S.C. §103.

Thus it now appears that the application is in condition for reconsideration and allowance. Reconsideration and allowance at an early date are respectfully requested.

If for any reason the Examiner feels that the application is not now in condition for allowance, the Examiner is respectfully requested to contact, by telephone, the applicant's undersigned attorney at the indicated telephone number to arrange for an interview to expedite the disposition of this case.

In the event that this paper is not timely filed within the currently set shortened statutory period, applicant respectfully petitions for an appropriate extension of time. The fees for such extension of time may be charged to our Deposit Account No. 02-4800.

In the event that any additional fees are due with this paper, please charge our Deposit Account No. 02-4800.

Respectfully submitted,

BURNS, DOANE, SWECKER & MATHIS, L.L.P.

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By: _____
Ellen Marcie Emas
Registration No. 32,131

P.O. Box 1404
Alexandria, Virginia 22313-1404
(703) 836-6620